NOx CONTROL FOR HIGH ASH COAL-FIRED PLANT

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PRESENTATION OUTLINE

- India – new norms and challenges
- NOx control in general
- NOx control options for high ash coal
- Multi-pollutant and emerging systems
New Indian norms are broadly similar to those in the EU and the USA

Controls will have to be installed on most of the units

Revisions expected after results of pilot tests are clear

<table>
<thead>
<tr>
<th>Plants built</th>
<th>Limits (mg/m³)</th>
<th>PM</th>
<th>SO₂</th>
<th>NOₓ</th>
<th>Hg</th>
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<tbody>
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<td>&lt;2003</td>
<td></td>
<td>100</td>
<td>600*</td>
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<td>200**</td>
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<td>* 0.03</td>
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<td>&gt;2003</td>
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<td>&gt;2017</td>
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*<=500 MW, ** >500MW
- Electricity demand is expected to increase more than three times by 2030
- Big push for renewable energy (40% of non fossil fuel capacity by 2030)
- Commitment to decrease CO$_2$ emission intensity (33-35% by 2030 from 2005 levels)
- Large coal reserves
• High ash coal
• Technical
• Financial
• Time constraints
• Materials and reagent availability
• No experience in continuous emissions monitoring (CEM)

The first technical guidance manual for emissions monitoring in India has been issued recently (CEMS, 2017)
There are a number of DeNOx technologies, which are broadly classified as primary and secondary measures. They are frequently combined together. Their NOx reduction rates and costs vary considerably.

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<tr>
<th>NOx REDUCTION TECHNOLOGIES: CAPABILITY VERSUS COST (XU AND OTHERS, 2015)</th>
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<td>Nominal NOx reduction, %</td>
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- Low NOx burners (LNBs)
- Over-fire air (OFA)
- Fuel biasing
- Low excess air
- Fuel reburning
- Flue gas recirculation
- Combustion optimisation

GE’s Low NOx burner (GE Power, 2018)
• Main options for India – LNBs and OFA
• Both technologies are already in use in Indian plants
• Recent developments in LNBs address specific requirements of Indian market
• **Following installation, careful measurement and control of combustion parameters is a must**

Doosan Babcock and Doosan Heavy Industries’ high ash coal (HAC) burner designed for Indian market (Wankhede and others, 2016)
• Selective catalytic reduction (SCR)
• Selective non-catalytic reduction (SNCR)
• Combination of SCR and SNCR?
• Multi-pollutant controls???

Basic principle of DeNOx (Kassi, 2016)
SCR achieves the highest NOx removal rates (80-90%) from all deNOx controls but is also the most expensive to install.

In India, around 279 existing units and 73 under construction may require SCR (Kumar, 2016).
SCR – CONFIGURATION CHOICES

(BHEL, 2016)
More than 85% of global systems are in this lay-out
Various impacts of fly ash but also number of solutions available
Common perception is that plate catalyst experiences less plugging than the honeycomb, but this is not the case
Successfully used in cement kilns, where dust loading is up to 100 g/m³

Three main types of SCR catalyst (Sadler, 2012)
SCR catalyst can be a key component for mercury oxidation.

(Vollmer, 2016)
• NOx reduction of 30-50%
• Number of vendors
• Proven in boilers firing high ash lignite and in cement kilns
• **In India, an SNCR unit will have to cover a greater area** and not all types of spraying nozzle will be applicable – this can be verified with CFD modelling and field tests
• **Urea may be a better choice than ammonia**
• SCR levels of NOx control achieved when SNCR used in conjunction with LNBs, OFA …
Fuel Tech Inc’ Advanced-SNCR

- Applicable to large boilers
- Use of advanced sensors to map the furnace and to control the location and manner of injection
- System successfully used in China since 2007, on a lignite firing boiler with 27.5% ash content

Advanced-SNCR using multiple nozzle lances from Fuel Tech Inc (de Havilland, 2016)
MOBOTECS'S ROTAMIX
Successful examples in Poland, where the system is installed on lignite-fired boilers with 28% ash content fuel

MOBOTECS'S ROTAMIX injector (Higgins and others, 2010)
GE’s UMBRELLA SNCR

- Relatively recent development
- Urea is sprayed within the furnace with a nozzle that is adjustable in height
- Tested on lignite with 34% ash content

GE’s UMBRELLA SNCR (Wilde, 2017)
All variations depend on the boiler characteristics.
(One lance for vertical and horizontal injections shown)
ReACT™

• A regenerative activated coke dry-type technology for SOx, NOx and Hg removal

• Placed downstream of the electrostatic precipitator (ESP) for particulate control, so is not affected by ash loading

• In commercial use for several years (Isogo power plant)

• One stage (50% NOx removal) or two stage configuration (80% NOx removal)

Photo: Isogo power plant, Japan. Source: Hamon Group
• NOx scrubbing
  • Injects ozone downstream of air heater
  • Converts insoluble NOx to highly soluble $N_2O_5$
  • Capture in a wet FGD
  • No $SO_2$ to $SO_3$ oxidation
  • 50-70% Hg oxidation

• Installed in the refining sector
• EPRI pilot demo on 550 MW coal-fired plant
• An option for Indian plants with a wet FGD?

(Liu, 2016)
NOx controls for high ash coals are broadly the same as for ‘regular’ boilers, but they must be customised to local market requirements, as has already happened with LNBs.

Following primary measures installation, appropriate monitoring and control of combustion parameters (combustion optimisation) is a must.

SNCR and SCR tests results from NTPC units will pave the way for the installation of these technologies in India.

Choosing appropriate NOx control systems for any power plant requires a site-specific strategy.
CCT2019 IN HOUSTON!

• The 9th International Conference on Clean Coal Technologies will be in Houston, USA, 3-7 June 2019
• A leading international event on the cleaner use of coal, covering CCS, high-efficiency plant, pollutant controls cofiring, gasification, and much more
• Join around 250 delegates from industry, research institutes, and government
• Site visits and venue to be announced shortly
THANK YOU FOR LISTENING

Any questions?

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